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Communicating Science

Interview with Yale-NUS educator Professor Chris Asplund and 17-year-old Founder-Convener of CogSci Connects, Tara Venkatesan

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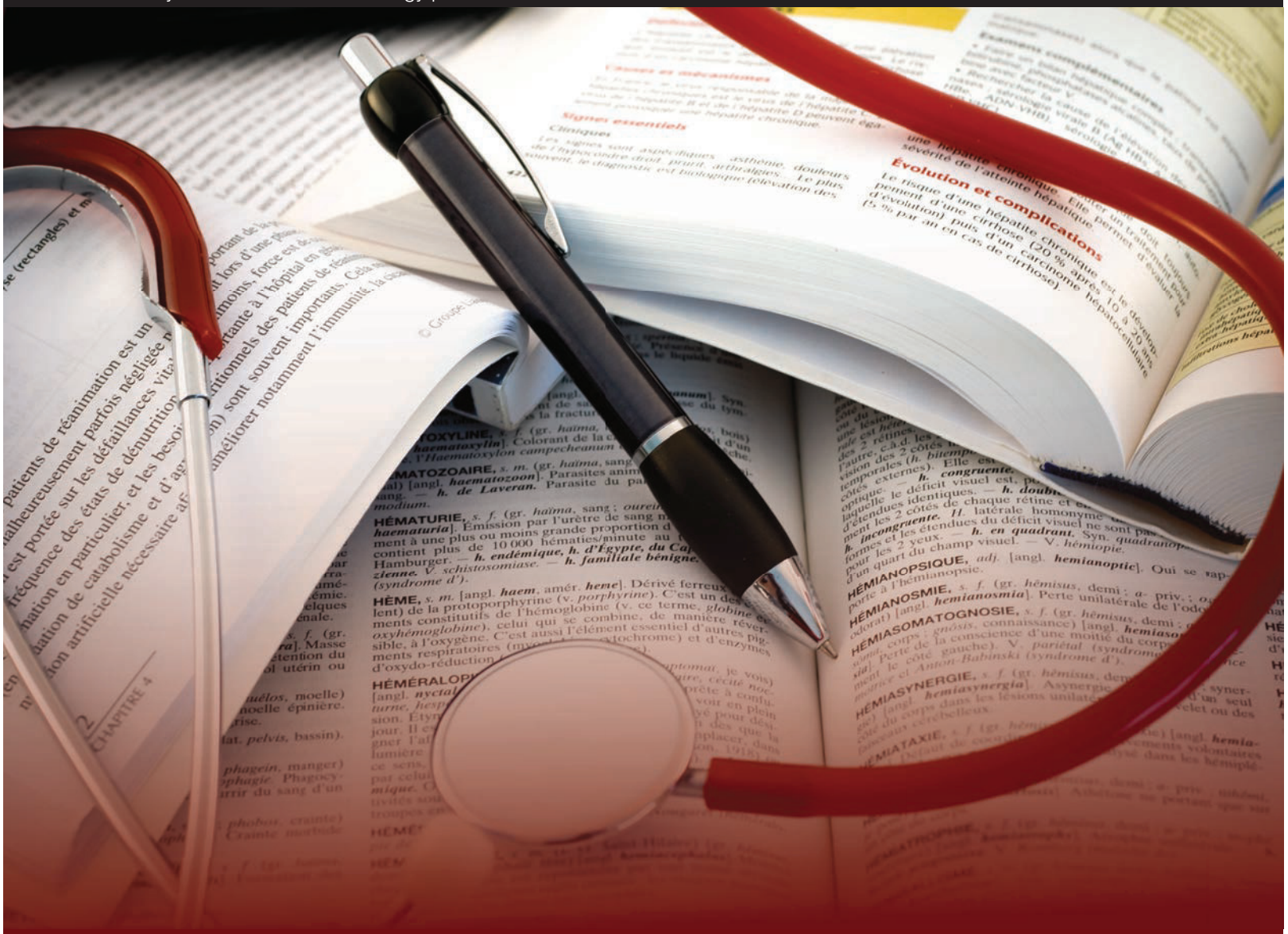

World Scientific
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Scientific Communication: In Search of One-Handed Scientists

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The Gravity of The Matter

Albert Einstein (1879-1955) is by far the most famous and beloved scientist of all time. We revere him not only as a scientific genius but also as a moral and even a spiritual sage whose enduring aphorisms touch on matters from the sublime (such as "Science without religion is lame, religion without science is blind") to the playful (such as "Gravity cannot be blamed for people falling in love"). There is a guesstimate of 500 books about Einstein in print, of which at least a dozen were published in 2005.

Why 2005? The year 2005 was the "World Year of Physics." That year celebrated the centennial of the "miraculous year" when a young patent clerk in Bern, Switzerland, revolutionized physics with five papers on relativity, quantum mechanics and thermodynamics. With other scientific giants, Einstein contributed greatly to the science of the twentieth century.[1,2]

For the first half of the twentieth century, physics yielded not only deep insights into nature, but also history-jolting technologies like the atomic bomb, nuclear power, radar, lasers, transistors and all the gadgets that make up the computer and communications industries. Physics also contributed greatly to the invention of tools that would prove essential for probing studies of life science today. Physics mattered.[3]

These days, biology has displaced physics as the scientific enterprise with the most intellectual, practical and economic clout. Biology has given us thrilling, chilling technologies like genetic engineering, cloning, genome projects, stem cells, and regenerative medicine. Many of our most pressing problems are also biological: AIDS, SARS, avian flu and other epidemics, ailments, overpopulation, environmental remediation, species extinction, even warfare (particularly biological warfare). We naturally look for answers to these problems not from physicists, but from scientists grounded in biology.[4]

It is fair to say no modern biologists have come close to Einstein's extra-scientific reputation. Einstein took advantage of his fame to speak out on nuclear weapons, nuclear power, militarism and other vital issues through lectures, essays, interviews, petitions and letters to world leaders. When he spoke, people listened. After Israel's first president, the chemist Chaim Azriel Weizmann (1874-1952), died, the Israeli cabinet asked Einstein if he would consider becoming the

country's president. Einstein politely declined—perhaps to the relief of the Israeli officials, given his avowed commitment to pacifism and a supranational government.[5]

It is hard to imagine any modern scientist, physicist or biologist, being lionized the way Einstein was. One reason may be that science as a whole has lost its moral sheen, or that the reputation of science has been tarnished. We are more aware than ever of the downside of scientific advances, whether nuclear power, genetic recombination, cloning, stem cell research or regenerative medicine; moreover, as science has become increasingly institutionalized, it has come to be perceived as just another guild pursuing its own selfish interests alongside truth and the common good.

One-Handed Scientist

Science at the dawn of the twentieth century was recognized as the dominating force of the age. Objective scientific analysis promised to open everything to human control. This is when science and technology began to become key issues in public decision-making.

Harry Truman (1884-1972) is the 33rd President of the U.S. After listening to his scientific advisors propose a well-argued hypothesis, and then escape from it with an "on the other hand," he is reputed to have pleaded for a "one-handed scientist" and said that he could solve the world's technical problems if he could just find a "one-handed" scientist.

The 34th U.S. President, Dwight D. Eisenhower (1890-1969), not to be outdone, is known to have made the statement, "I'm a physicist and I just can't resist saying, 'on the one hand... but on the other hand'..."

Or was it U.S. Senator Edmund Muskie (1914-1996) who first pleaded for a "one-handed scientist"? It was a time when supersonic transport was first coming into the U.S. and the senate was trying to decide whether it would create giant holes in the ozone layer. Senator Muskie had a big hearing on Capitol Hill and he called expert scientists together. A blue ribbon panel presented their findings and said, "Our findings show this, that the preponderance of data is that it won't cause any danger. On the other hand, our data shows just the opposite, also, that we need to do more research." It was at this point that Senator Muskie got up and quipped, "Will somebody please find me a one-handed scientist?"

Researchers learn early in their careers about the fine line between cautious explanation and avoidance; this is especially so when it comes to the demand for simple answers to complex scientific questions. In the policy arena, for example, elected officials dream of the "one-handed" scientist. Researchers offering scientific expertise often state a likely option based on analysis of data, and quickly follow with "but on the other hand," proceeding to describe layers of factors that might rule out science's best guess at the moment.

But people want answers, and can become frustrated by responses that are a long list of options, potential factors and qualifiers.

Uncertainty, probability, change and refinement are inherent aspects of science. The popular view of uncertainty, however real, carries images of bumbling, ineptitude, indecisiveness, weakness, and almost subversive, but all the word really means is that there is something we do not know. It may be an unknowable like the future, it may be something beyond the current state of knowledge of science, or it may be something easy to ascertain like a phone number. Whether or not someone else knows it, if you yourself do not know it, you are harboring uncertainty.

But if you find someone who claims to know everything, then you will have found someone to avoid. The fact is that life can be understood backwards, but unfortunately it must be lived forwards. The arcane probabilistic theories that scientists used to predict the future go both ways; the theories commonly use the past as inputs to forecast the future.[6]

Now you see why Einstein is by far the most famous scientist. He was not only a genius, but also a "one-handed" speaker. When he spoke out on vital issues through lectures, essays, interviews, petitions and letters to world leaders, he spoke with "one-handed" authority. Recall that Truman was the U.S. president who decided to drop the two atomic bombs in Nagasaki and Hiroshima during World War II. Einstein had written Franklin D. Roosevelt (1882-1945), President Truman's predecessor, and warned him of the danger of atomic bombs. President Truman could not be referring to Einstein when he was pleading for a "one-handed scientist": Einstein wrote to FDR; Truman dropped the bombs.

Professionals and Professors

Business professionals and technologists work in a myriad of small, medium and large companies that rely for their financial health, if not their very survival, on the reactions of the market forces to their inventions. Traditionally, the academia competed in a very different environment. They were nurtured in research institutes and university laboratories, where in tenured positions, salaries were more or less assured and professional rewards and recognition were meted out through an elaborate system that included literature citations, research grants and prizes such as the Nobel prizes.

The current generation of new academia is likely to be more entrepreneurial-minded, or to be reduced to making obsequious gestures toward those who hold the purse strings on their payroll checks and research.[7]

Intellectual property, for example, offers legal control over the creative productivity of the human brain, but the technical boundaries between what can be maintained under personal or professional control and what may be freely circulated for others to capture and manipulate are not yet clearly defined. Consequently, the long-standing tradition of "each generation standing upon the shoulders of previous generations" is no longer tenable because of the tendency to patent, copyright or license everything, by not only entrepreneurs, but also by scientists![8,9]

Opportunists abound. Look at all the healthcare products (supplements, pharmaceuticals), nutritional products (functional foods, nutraceuticals), beauty products (skincare products, cosmeceuticals)... that are jostling for our attention on the shelves of pharmacies, health food stores and supermarkets. And all those

network marketing or multi-level marketing (MLM) micro-franchises. Be wary of manufacturers making exaggerated claims about or over-selling the benefits of their products. Many of these manufacturers, especially network marketers or MLM, even go all out to recruit scientists to be their spokespersons to lend credibility to their claims.

Fear mongering is one of the best ways to put a message across. It is an instinctive human reaction. In these modern days of networked society, search engine carpet bombing is yet another effective way to (mis)inform. Search engine carpet bombing is a way of manipulating search engines by dominating results through networks of interlinked sites; the idea is to bombard (the information, or message for that matter) repeatedly, widely, or excessively like in carpet bombing the country with advertising. This would create a false impression that the claims of the manufacturers, bogus or not, are corroborated by other sites.

While some of these claims are supported by research, others greatly outstrip the scientific evidence. But just because commerce (for example, stem cells in cosmeceuticals) has galloped ahead of science does not mean there is no scientific basis for manipulating the results of scientific research for the good of humanity, for example, to improve health (through stem cells and regenerative medicine).[10,11]

Credible scientists are generally much more patient with the progress of knowledge—continually self-correcting, building on prior knowledge but never absolute—than nonscientists. Other activities, particularly politics and business, call for quick and definitive answers. In the legal profession, most laws—being an accumulation of almost unchanging laws—are in fact irrelevant in a society that is constantly changing. Time-tested circumlocutions in the legal profession are not uncommon. This tension between science, legal profession and non-scientific activities may be irreducible.

The journalist is often in the position of posing questions to which the research world can offer no authoritative answer, but can offer just a cautious account of the current state of informed belief, including the "on the one hand... on the other hand..." type of answers. Inevitably, some members of the public will ignore all the caveats (such as "this is just a preliminary study," "the sample isn't representative of the population," "we won't know for at least two more years," "it's only been tested on mice") and believe whatever they want to believe, or believe in one hand more than the other. Sensationalism will always build an audience in the short run; responsible journalists recognize this tendency and resist the temptation to abet it.[12]

Effective Communication

Under all these externalities: policy-decisions, legalities, journalism, financial lure, opportunistic rush, potential for patents, and pressures from other sectors, how should scientists juxtapose themselves? A way is to communicate, communicate much better than they have been doing to date.

Scientific communication is not only important to reestablish the moral sheen and to improve the image of science, but also is an integral part of a successful scientific career. And yet this is a crucial competence that many scientists seem to overlook.

In any communication, there is a presenter and there is an audience. The presenter can be a scientist (like Einstein), and the audience can be a person (such as President FDR, in which case it is one-to-one) or a group of people (in which case it is one-to many). The medium of presentation can be oral (like in a one-to-many lecture), written (like in a letter, email, in which case the audience is a reader(s)) or in video (like on Youtube in which case the audience is a viewer(s)).

To be audience-friendly, a communication should strive to see things from the audience's perspective, that is, on what the audience

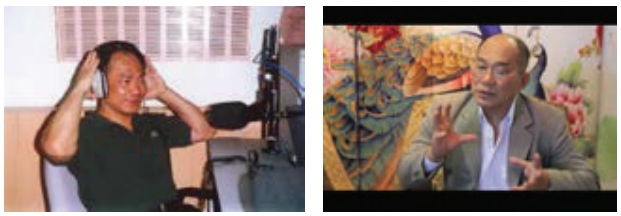

Photo 1. (l) At the peak of the SARS epidemic, Hal is explaining SARS on a radio interview "Rush Hour", Los Angeles, California, May 29, 2003. On a radio, the audience cannot see the presenter. Intonations are very important. (r) Hal on TV talking about information overload in "Face2Face", San Francisco, California, September, 2012. On TV, the audience can see the presenter, and gesturing helps in bringing out a point.

needs or wants to learn or know, and NOT what the speaker feels like telling. In the case of a mixed audience, focus on at least those who matter for the purpose, not just those who are experts in the fields, or like-minded people.[13]

Effective or audience-friendly communication is about getting the message across, involving capturing the audience attention to ensure that they understand the idea and to encourage them to remember, apply or provide feedback. Here we distinguish between information and message: a message is the interpretation of the information; it says what the information means to the audience. Information is the answer to the "what" question, and message is the answer to the "so what" questions. For example, Einstein wrote FDR to inform him of the danger of atomic bombs ("what" part), and advised him against the use of the weapon of mass destruction ("so what" part).

(l) Hal, and a few pioneers of the genome project, in the early days of the project, at a town-hall style press conference to explain the genome project to invited guests and members of the press, April 1990, Florida Press Club, Tallahassee, Florida, USA. (r) Hal was in Jeddah, Saudi Arabia, lecturing on bioinformatics to an auditorium where the female (in abayas and veils) and male audiences were seated in different halves of the auditorium, April 2002.

In a written document, the audience (readers) need not read every single word, can reread parts of the document, and can read at their own pace. In this case, the goal is to convince through solid, detailed evidence and therefore the structure of the document is to enable selective reading. FDR probably reread Einstein's letter, in pertinent parts, several times.

The audiences of oral presentation (listeners) are at the mercy of the speaker; they cannot select what, nor which order, they want to listen to. They are usually less interested in the details, which they can more easily read in a document. On the other hand (see this handedness appears again), they can interact with the speaker through questions or discussions. In an oral presentation, the goal is to convince by coherent arguments, articulating them logically, taking into good account the mix of audiences.

In this respect, speakers in science are usually very ineffectual. Speakers in science tend to make their presentations complicated for fear of being too simple; to command respect and authority in the field, they speak in lingoes. Many attendees actually would wish the presentation were aimed at a more understandable level. While few attendees will complain that a presentation is too simple, many will react negatively to speakers who address them as if they are stupid! The main purpose is to get the message across, not to impress or insult.

The purpose of communication is what you want the audience to do as a result of reading or listening to what you have written or said. To communicate effectively is to adapt to the audience.

Audiences vary. They can be small (like in a seminar) or large (like in a colloquium or public lecture); they can be homogenous or heterogeneous; some are well known (like Einstein's letter to US president FDR), others can be less well defined, as publishing in a magazine. It also helps to identify specialists from nonspecialists, and between primary and secondary audiences. Specialists will likely want more details. These people can apply detailed information in their own work, or they might need to be convinced of the validity of your conclusion(s). Nonspecialists, including some bean counting policy-makers, on the other hand, will need more basic information (such as in the introduction) and more interpretation (such as with the conclusion). Most of all, they will need simpler vocabulary, rather than trade lingoes and jargons.

A scientific paper aimed for a peer-reviewed journal, which is a specialized publication, will likely also be consumed by newcomers to the field who are less specialized. Even reviewers of the journal cannot have equal degree of expertise in all the subject areas they have to review. This is especially true if the author is one of the few authorities in the field, or if the field is arcane!

The context also comes into play. When writing a document, a memo for example, to a single person or well-defined group, you may be tempted to jump into the crux of the matter. This audience, who are the primary readers, may indeed know the context. In these days of "FYI", email... the document is very likely to get forwarded and end up in the hands of a secondary audience. This secondary audience will not know the context. An effective document makes sense to both the primary and secondary audiences.

When addressing an audience, it is important to bridge the gap between what they know and what you want to present early in the presentation. This gap is wider with nonspecialists than with specialists. Nonspecialists lack comparison points. For example, in nanotechnology, nonspecialists cannot tell the absolute value of the size of a nanometer, whether it is a small or a large dimension. However expressed in terms of "as small as one-fifty-thousandth of the width of a human hair", a nonspecialist will know it is a very small size indeed since a human hair is quite thin. An absolute value that "this eco-friendly light bulb uses 5W" is not as useful as saying that "this eco-friendly light bulb uses only a tenth of the wattage of a regular light bulb".[14,15]

A parallel or analogy always helps in introducing something new. Drawing a parallel between a new concept and something that is familiar increases the likelihood that the audience will understand and remember. For example, the human genome is like instructions in a set of encyclopedia of 23 volumes (chromosomes), written in four alphabets of A, C, G, and T rather than the usual 26 alphabets.4

A picture is worth a thousand words. Visual materials appropriate for all audiences and crucial for nonspecialists, can include drawings, charts, photographs, videos... Drawings, which can abstract unnecessary details to focus on the essential idea, are best suited for conceptual explanations, while photographs give a better idea of what the real thing looks like. For example, in explaining how to extract solar power for home use, it may be useful to have a diagram to show sunlight hitting on solar panels and how the solar energy is converted into electricity for consumption; it may also be useful to provide a photo showing an installation, perhaps with a human standing next to the solar panel as a comparison point for the actual size of the solar panel.[16]

Presenting a Novel Idea

"If you can't explain it simply, you don't understand it well enough." This is attributed to Einstein. Despite the predictive power of the theory of relativity and the great intellect of Albert Einstein, an estimate says 99% of those people who have lived and are living do not know what relativity is and who Einstein is or who Einstein was.

Almost all scientists, like Einstein and other great minds of science, are constantly pushing the envelope to progress knowledge—continually self-correcting, building on prior knowledge but never absolute; once in a long while, a scientist will come up with something novel. "Novel" like in "new and not resembling something formerly known or used", such as in "a novel particle", "a novel idea"... that is groundbreaking.

When presenting a novel or creative idea, it is not enough for it to be novel; it must have value or be appropriate to the cognitive demands of the situation. In other words, we have to consider the following:[17,18]

- ☑ The domain, which is nested in culture––the symbolic knowledge shared by a particular society or by humanity as a whole (e.g., visual arts, science, religion, etc)

- ☑ The field, which includes all gatekeepers or judges of the domain (e.g., art critics, reviewers, religious leaders, etc)

- ☑ The individual person, who using the symbols of the given domain, (such as music, engineering, new technologies, business, mathematics) has a new (novel) idea or sees a new (novel) pattern. In our discussion, this person is the scientist.

Being so novel or unprecedented, it may be rejected outright or it may take some time for this novelty to be selected by the appropriate field for inclusion into the relevant domain.

There is a plausible explanation. Down through the centuries much philosophical ink has been spilled over the question of whether human beings are free to decide and act or whether our decisions and actions are determined by external forces: heredity, environment, history, fate, peer pressure, Facebook, Twitter…

Sir Edward Burnett Tylor (1832-1917) introduced the concept of survival (*not* the same "survival" as in "survival of the fittest"). In this case, survivals are ancient customs or habits that had persisted long after their original purpose had been lost or forgotten. Many of our instinctive reactions and emotions are on occasions at odds with this modern age because survivals continue to shape the way we live.

In parts of the world where modern mores often collide with ancient traditions and customs, what constitutes progress can be debatable, and in some cases, even divisive. For example, in cloning, stem cell research and regenerative medicine, science and religion have been clashing head on.

This is quite understandable. Biology is the most intimate of the sciences. It deals with some of life's most wondrous occurrences, with reproduction and birth, with human abilities and limitations, with diseases, and with death. It seeks scientific explanations of these things, an understanding of how they occur and often why they occur. But explanations do not eliminate the wonder.

With the new repertoire of tools of genetic engineering and cloning, biology is not just the science of what we are and of how we came to be who we are, it has become the science of what we can become. Still, no matter how much we know about being human, we will always be human, guided by societal rules and customs, and now by the number of "likes" on Youtube and Facebook, and tweets on Twitter.

Conventional wisdom holds that science and technology speed at a dizzying pace headlong into the future, leaving law, ethics and social policy laboring to catch up. While this wisdom may be true in many of the cases, the reverse can also be true when society at large has a lot of warning of what is coming. But policy makers might move too fast toward rigid social policies in an effort to avoid being caught off guard.[19,20]

So when a novel idea (new domain) comes into being, to deliver its message, the first task of the individual person is to overcome resistance from the field. To this end it is necessary to educate the field to gain initial acceptance. The genome project, for example, when it first started, encountered a lot of resistance from traditional cottage industry biological science community, policy-makers and later from the public. The genome community (the individual(s)) did an outstanding job to convince policy-makers (one of the field(s)) during congressional hearings and in conferences to get the project started. Through further media appearances, conferences and publications, and convincing breakthroughs, the public began to change their opinions, even their hearts. And now the genome project is in its full swing. Stem cell research and regenerative medicine have gone through the same process and are now coming up with breakthroughs in curing diseases.[21]

Action Is Louder Than Words – Social Media

Words are mightier than swords. In many instances, action is louder than words. Consider the following two scenarios.[22]

Scenario One. A physician runs a physical check-up for a young person, say twenty years old. If the readouts should indicate any abnormality, say an elevated level of blood sugar, the physician would immediately become very concerned and would promptly prescribe a special diet, medication and exercise. In short, the physician would immediately attempt to correct what is perceived to be a health problem.

Scenario Two. A physician runs a physical check-up for an elderly person, say seventy years old. Upon seeing the elevated level of blood sugar in this patient, the physician would dismiss it as the inevitable result of advanced years or senescence.

Depending on the context, the tone of the physician, cultural backgrounds… the message to the patients can be very different.

Professionally, in the case of the older person, the exact same condition that would be regarded as "normal" would be deemed problematic and needing treatment in the younger person. This is antithesis to good medicine, and a depressing and fatalistic approach of contemporary medicine. Most diseases, including high blood glucose levels, are dangerous to people of all ages and can cause diabetes, hardening of the arteries, heart attack and stroke. Senescence, the downward spiral that is the hallmark of aging, is inevitable, but can be delayed.

Our modern economic and social systems are excellent, but not without flaws. In some instances, they are misinterpreted or misused. Take insurance policies as an example. The problem with most insurance policies is that they pay for drugs, surgeries and treatments. Despite all the talks about medicine, we are really living in an era of reimbursement-based medicine. In the scenarios mentioned above, besides that the older man is showing signs of senescence, may be the young patient has a better insurance policy?[23]

The message comes across loud and clear, even though the physician utter few words, if at all.

This is a case of communication in which the actors (the doctor and the patient) see each other. The physician and the patient also have physician-client privilege––a legal concept that protects the confidentiality of the conversation (communication) between the physician and the patient from being used, especially in legal proceedings in the court.

Social Media

In social media, in most instances, actors not only do not see each other, but also do not know each other and will never meet each other. They also want their communications to disseminate as far as possible––to members within the network and then beyond to the members of the networks of the members of the first network. A tenet of social networking is to communicate, but it is not so easy to communicate when you talk in less 140 characters on Twitter. When social networking first came about less than ten years ago, it was not well received. Social media community charged on, and it seems like they prevail eventually. It is a new world, with a very new way to communicate.[24]

There is a specific kind of narcissism that the social Web engenders. By grooming and updating your various avatars, you are sending a certain message and are making sure you remain at the popular kid's table. One of the more seductive data points in real-time media is the reciprocating message of what people think of you. The metrics of followers (in "likes") and retweets beget "a kind of always-on day trading in the unstable currency of the self".

But all is not vanity. For those of us who are afraid of missing something, having the grid at our fingertips offers reassurance that we are in the right spot or gives indicators of heat elsewhere. For anybody with children, a job or a significant other, the expectation these days is that certain special people, usually beginning with our bosses, can reach us at any minute of any day. Every once in a while something truly important tumbles into our in-box that requires immediate attention.

In this context, mobile devices do indeed make us more mobile, but that tether is also a leash, letting everyone know that they can get you any second, most often to tell you they are late, but on their way—the traffic, of course, is a very handy excuse. This is yet another bit of bad manners that the always-on world helps facilitate, directly or indirectly.

It used to be when someone picks up the telephone the question is "Who is on the line please?" because the telephone is at a fixed location and anyone nearby can pick up the telephone; with personal mobile phone, when someone answers, the question is "Where are you?" because we know who the owner of the cell phone is, but (s)he can answer from wherever (s)he is, most of the time, very unfortunately, stuck in the traffic and late for appointments.

This is the brave new world of communication.

Conclusion

See, I just got my point across: on the one hand, it is important to communicate; on the other hand, effective communication is an art; on the third hand, it is very difficult to put a novel idea across, not to mention overcoming initial resistance; on the fourth hand, if this has not been attempted, science and technology would have reached a stagnant point, and we would still be leading a very austere life: no theory of relativity, no genome projects, no stem cell research, no regenerative medicine, no Youtube, no Facebook, no Twitter... I have now become not only a one-handed scientist, but also a Ganesha-like entrepreneur.

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About the Author

Dr. Hwa A. Lim is an internationally respected authority on bioinformatics and biotechnology. Currently he is active in both the academic and the private sectors.

Besides his many appointments as scholar, technologist and entrepreneur, Dr. Lim is an articulate and well sought-after speaker at international meetings. He travels extensively to do business, to lecture, and to mingle with locals to experience and learn firsthand––something that he enjoys as a author writing on diverse topics. He is a Kingstone Best-Seller author and the author of more than 10 books in English.

Dr. Lim is credited with coining the neologism "Bioinformatics", establishing and shaping the field, and initiating the world's very first bioinformatics conference series. He chaired the first ten conferences of this "Bioinformatics and Genome Research" international conference series. These pivotal roles and credits earn him the title "The Father of Bioinformatics."

As a bioinformaticist, he has served as a bioinformatics expert for the United Nations to help set up biotech research parks, and as a review panelist for United States federal agencies (including National Cancer Institute, National Science Foundation), and as a consultant for prominent consulting firms (VAXA, McKinsey), financial firms (Robertson Stephens, Prudential), biotech, pharmaceutical and healthcare companies (Eli Lilly and Company, Monsanto and Company), organizations, and governments (China, France, India, Korea, Malaysia, Saudi Arabia, U.S., and Taiwan).

Dr. Lim gained his Ph.D. (science), M.A. (science), and MBA (strategy and business laws) from the United States, his B.Sc. (Honours) and ARCS from Imperial College of Sc. Tech. & Medicine, the University of London, United Kingdom.

He currently resides in Santa Clara, "The Heart of Silicon Valley"SM, California, USA, which, besides the high concentration of high-tech companies, has the largest cluster of life science companies.